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THE EFFECT OF LARGE ANGLES OF YAW ON THE ACCURACY  
OF WING-TIP YAWMETERS

By Jacob Golden

Langley Memorial Aeronautical Laboratory  
Langley Field, Va.

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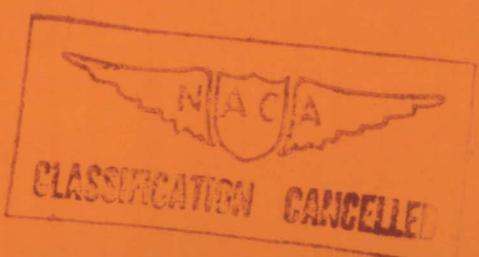
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THE EFFECT OF LARGE ANGLES OF YAW ON THE ACCURACY  
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INTRODUCTION

The present method used by the NACA for the measurement of sideslip angles in flight involves the use of a device called the yawmeter. The operation of this instrument depends on the motion of a free-swinging vane which, mounted ahead of the wing tip, aligns itself with the local wind direction. Because of the flow pattern about the airplane, the local wind direction at the yaw vane may be slightly different from the direction of the relative wind and the yaw-vane readings may be in error. This error is corrected by using half the difference between the readings of two vanes, one on each wing, for unyawed flight as a calibration constant. It is possible, however, that, because of the change in location of the vane with respect to the flow pattern at large angles of yaw, the constant obtained for unyawed flight may not apply. The present report covers power-off tests made in the free-flight tunnel to check the validity of this method.

DESCRIPTION OF APPARATUS

A 1/10-scale model of the Republic XP-41 airplane was used in the tests. Yaw vanes were located on each wing of the model as shown in figure 1. The details of the installation are shown in figure 2. The vanes were made of 1/16-inch balsa cemented to 1/16-inch aluminum tubing, which acted as a bearing. The tubing swung on a 0.040-inch music wire attached to the wing.

TESTS

The model was mounted on a fixed stand at an angle of attack of  $8^{\circ}$ , which was slightly below the stall for the test Reynolds number. The tunnel airspeed was held

constant at 59 feet per second and the model was locked at various angles of yaw between  $40^{\circ}$  and  $-40^{\circ}$ . Simultaneous readings were made of the angles of yaw for the model and for the vane at each wing by means of a 35-millimeter motion-picture camera located on top of the tunnel.

### DISCUSSION

The results are given in figure 3. The yawmeter error is the difference between the yawmeter reading and the true wind direction as shown in figure 1. The plotted points are averages of ten consecutive readings taken at each angle of yaw to compensate for the effect of vibration of the vanes due to the elasticity of their mounts and to momentary unsteady flow past them. There was, nevertheless, a large scatter of the test points, probably due to two causes: first, it was difficult to read the yaw vane angles accurately because of the extremely short lengths of the vanes; and, second, the true variation of vane angles with time may not have been represented by consecutive pictures taken  $1/16$  second apart. The faired curves, however, seem to fit the test data reasonably well despite the scatter.

### CONCLUSIONS

The results of tests made in the free-flight tunnel indicate that the existing method of calibration of a yawmeter is exactly correct at zero yaw and that, at  $\pm 40^{\circ}$  yaw, the error is less than 1° for power-off flight.

Langley Memorial Aeronautical Laboratory,  
National Advisory Committee for Aeronautics,  
Langley Field, Va.

NACA

Figs. 1,2

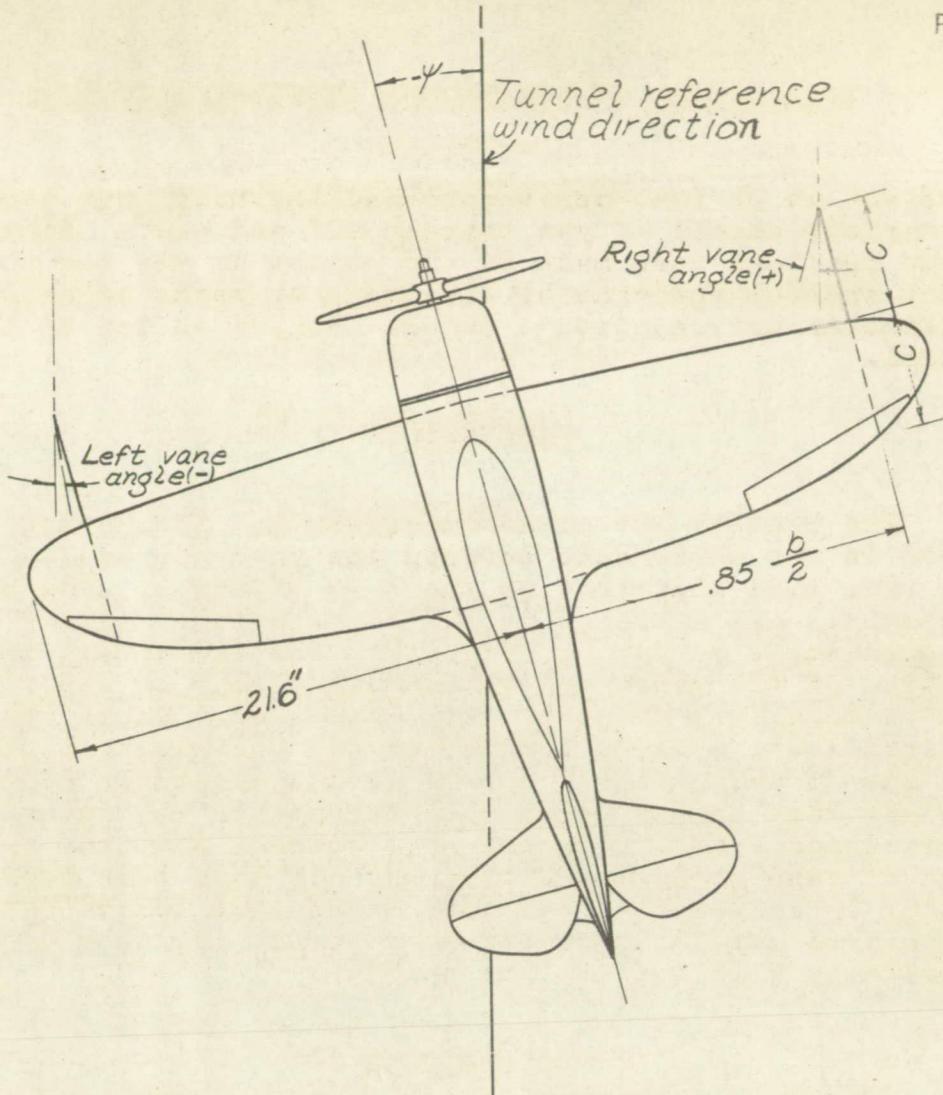


FIGURE 1.—Diagram of  $\frac{1}{10}$ -scale model of Republic XP-41 airplane as tested in free-flight tunnel.

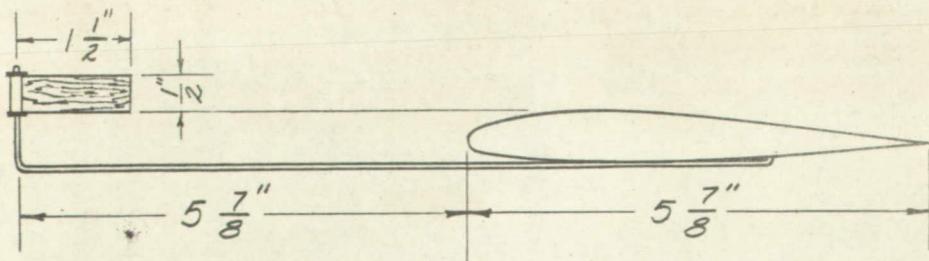


FIGURE 2.—Section of wing showing yaw-vane installation on  $\frac{1}{10}$ -scale model of XP-41 airplane.

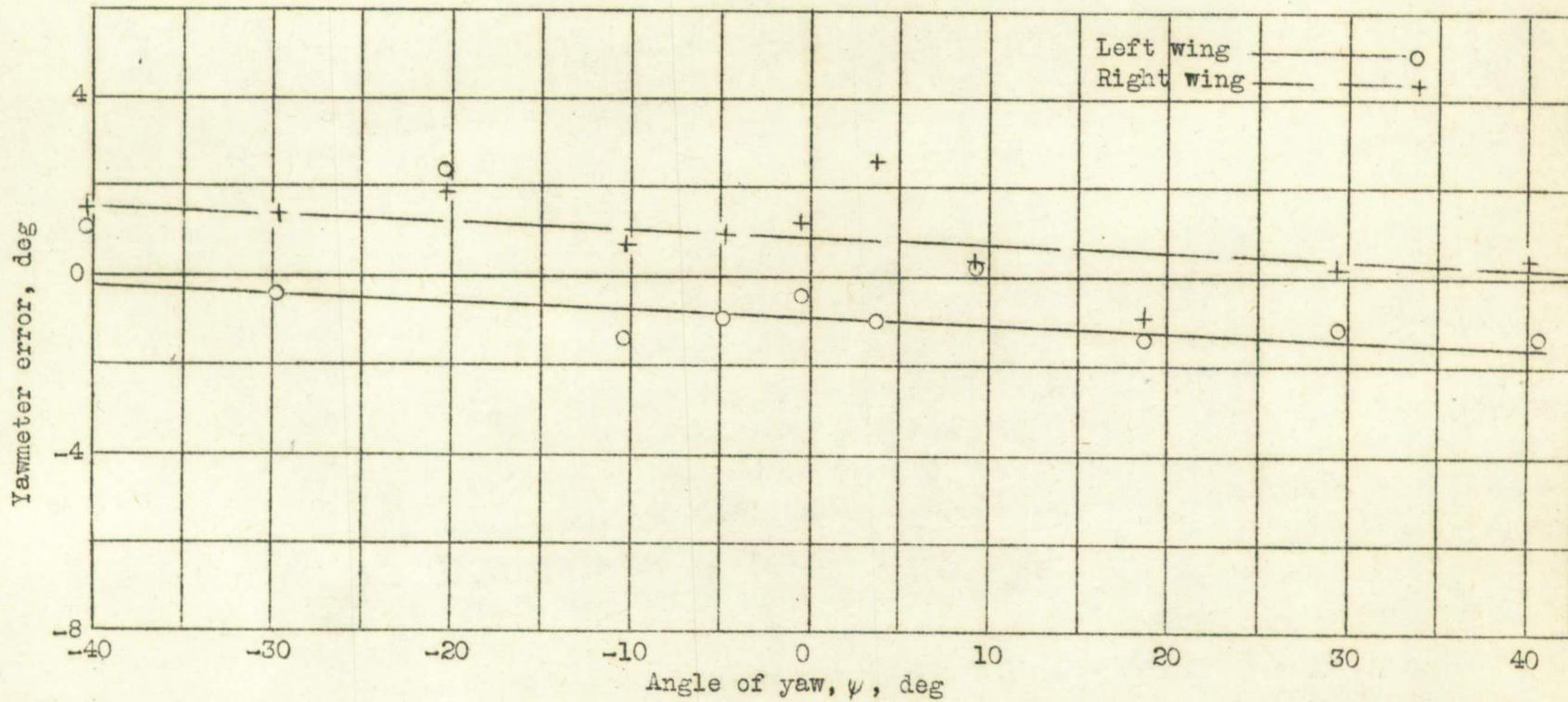


Figure 3.— Variation of yawmeter error with angle of yaw as determined from power-off tests in free-flight tunnel.